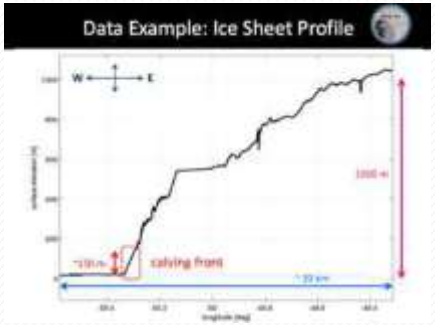
Arctic Focus of the NOAA Unmanned Aircraft Systems (UAS) Program

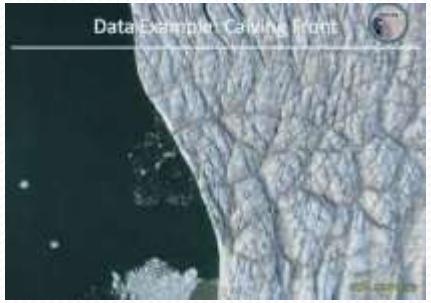
Robbie Hood
Office of Oceanic and Atmospheric Research
21 June 2011

Polar Monitoring - Greenland Glacier and Ice Seal

Testbed Co-leads: **Dr. Elizabeth Weatherhead (University of Colorado) and Dr. Robyn Angliss (NOAA/ National Marine Mammal Laboratory**
Partners: **Greenland Glacier Study / University of Colorado and BAE Systems -Advanced Ceramics Research**
Bering Sea Ice Seal Study / University of Alaska- Fairbanks and Boeing - Insitu

Greenland Glacier Study - 2008



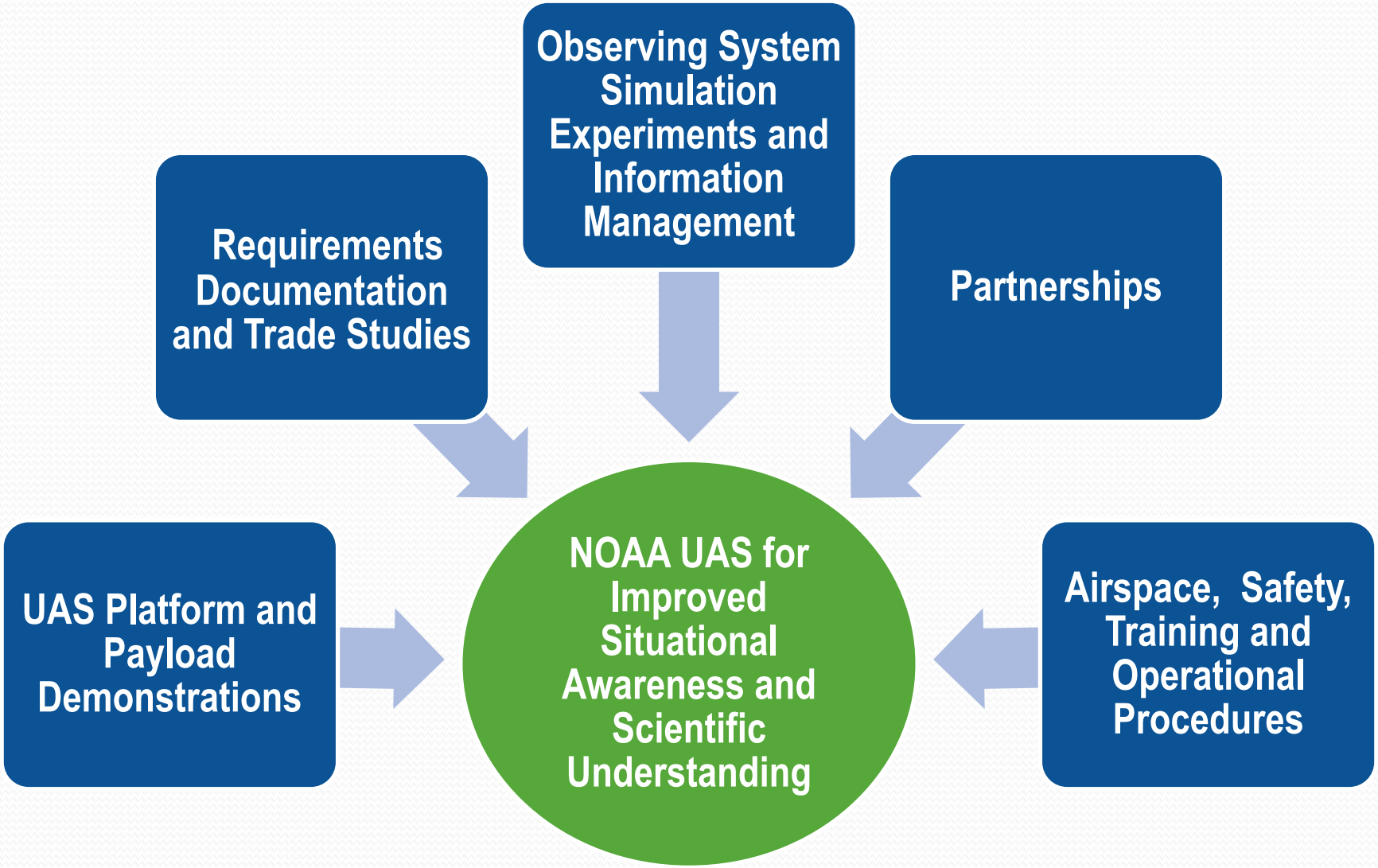


Images courtesy of James Maslanik, University of Colorado

Bering Sea Ice Seal Study - 2009

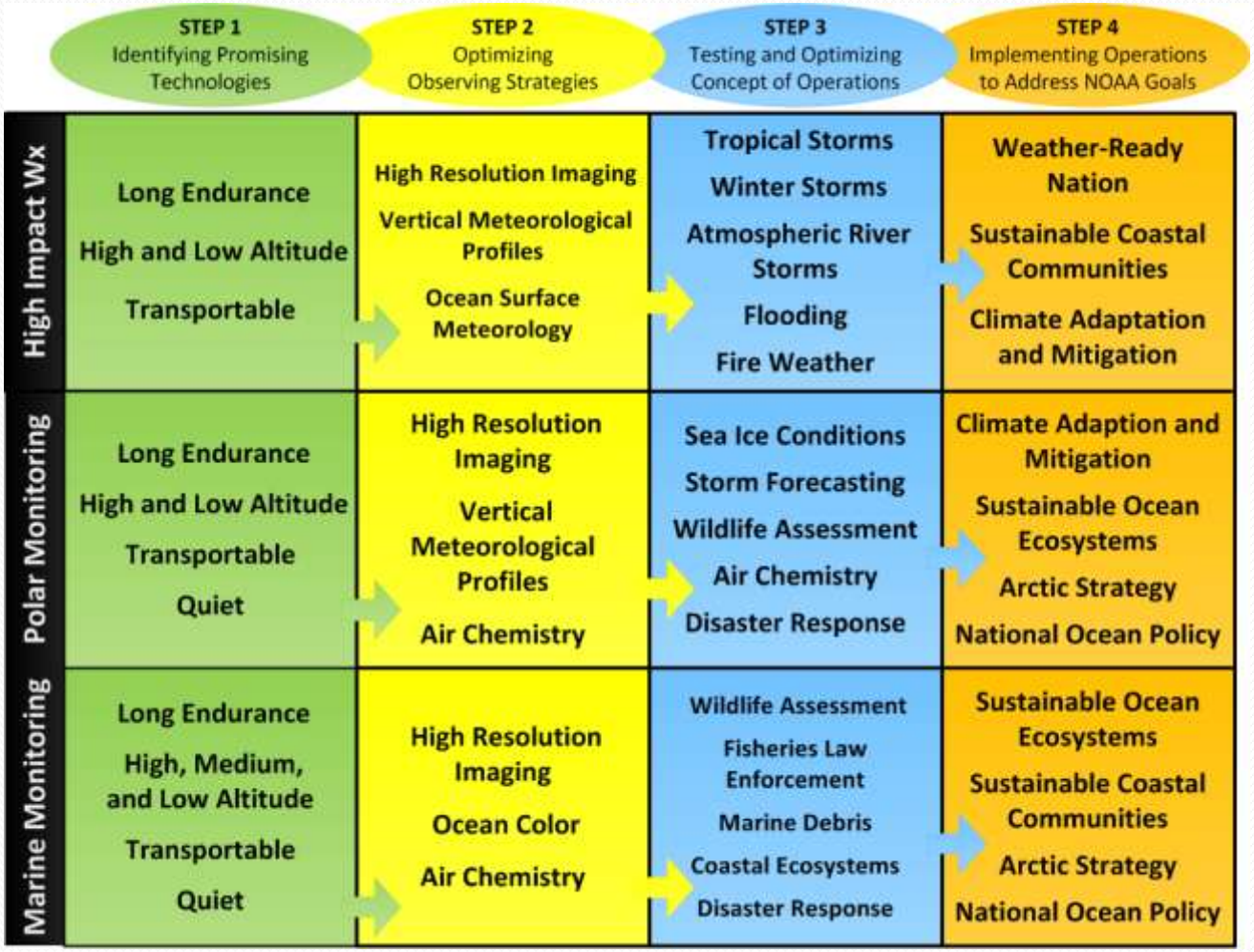
Images courtesy of Greg Walker, University of Alaska - Fairbanks

Tools for Building UAS Capacity



NOAA UAS Roadmap

Innovate	*Incubate*	*Integrate*

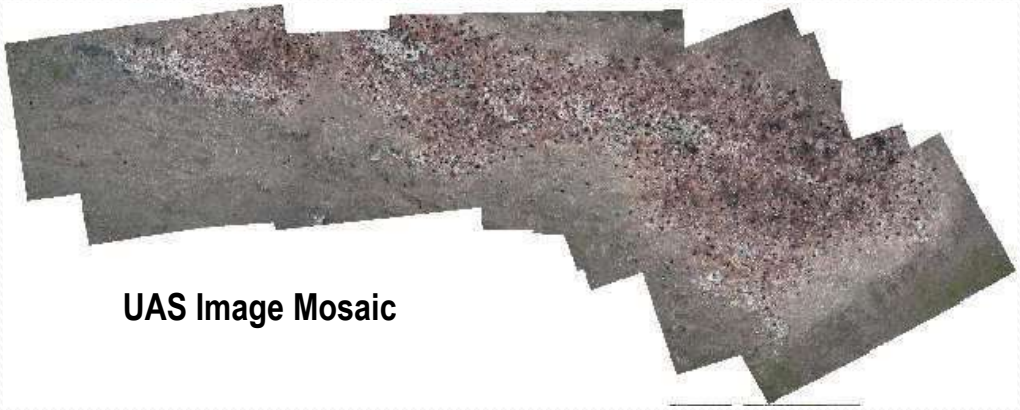


Antarctic Wildlife Assessment

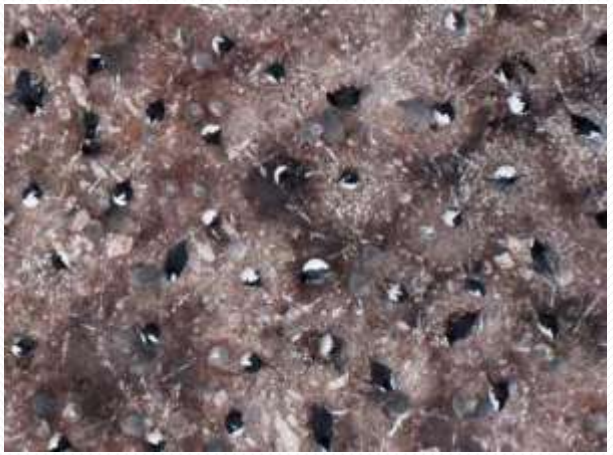
Sample species on Cape Shirreff, Antarctica

UAS with Olympus EL-1 Camera

UAS Operator with Vehicle



UAS Image Mosaic

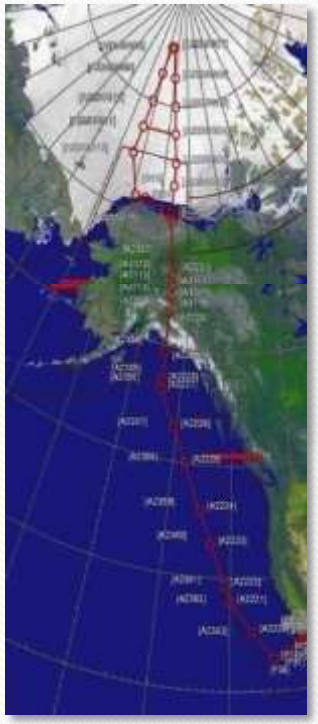


Single UAS Image

Project Leads: Wayne Perryman (NOAA/ SWFSC) and LCDR Nancy Ash (NOAA/AOC)

Global Hawk Pacific (GloPac) Experiment

A partnership between NASA , NOAA, and Northrop Grumman

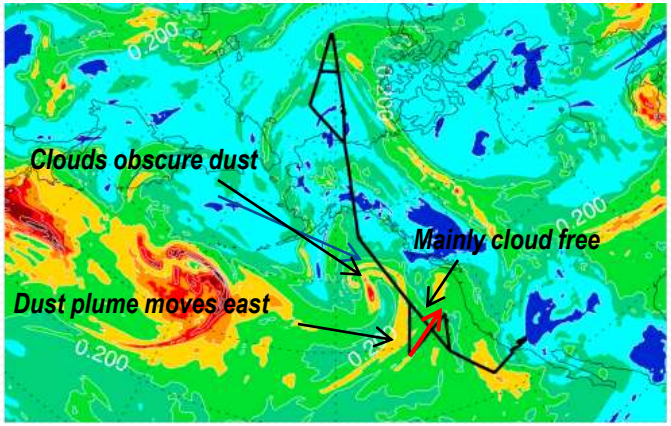


- **Mission Scientists: Paul Newman (NASA/GSFC) and David Fahey (NOAA/ESRL)**
- **First Global Hawk flight north of 70º N.**
- **First Global Hawk mission to have pole to pole command and control, and payload communications links.**

One Mission – Two Oceans

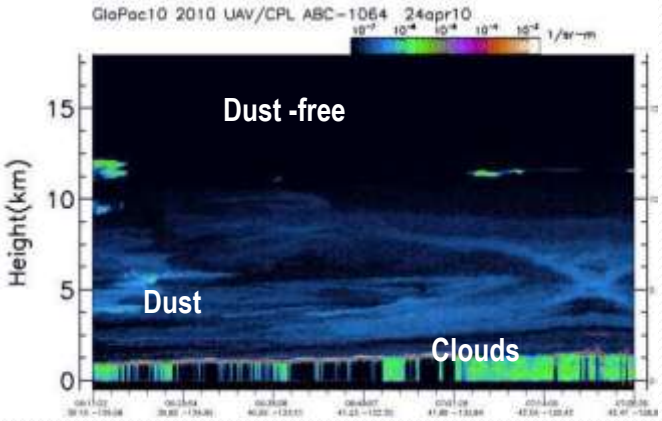
23 April 2010 Global Hawk Accomplishments

- Flight endurance – 28.6 hrs; Flight range – 9700 nm;
- Maximum altitude – 19.9km; Maximum latitude – 85N
- First time any Global Hawk has ever traveled north of 70 latitude
- Collected, recorded, and relayed real-time readings of *in situ* stratospheric ozone, water vapor, methane, carbon monoxide, nitrous oxide, hydrogen, and sulfur hexofluoride concentrations along entire flight track
- Captured high definition visible imagery of sea ice
- Cloud Physics Lidar remotely sensed dust concentrations crossing the Pacific Ocean from 31 March 2010 Gobi Desert dust storm



NASA aerosol model forecast and Global Hawk flight track

High definition visible images of sea ice captured by NASA Airborne Compact Atmospheric Mapper



Aerosol vertical profile observed by Cloud Physics Lidar along red arrow of flight track above

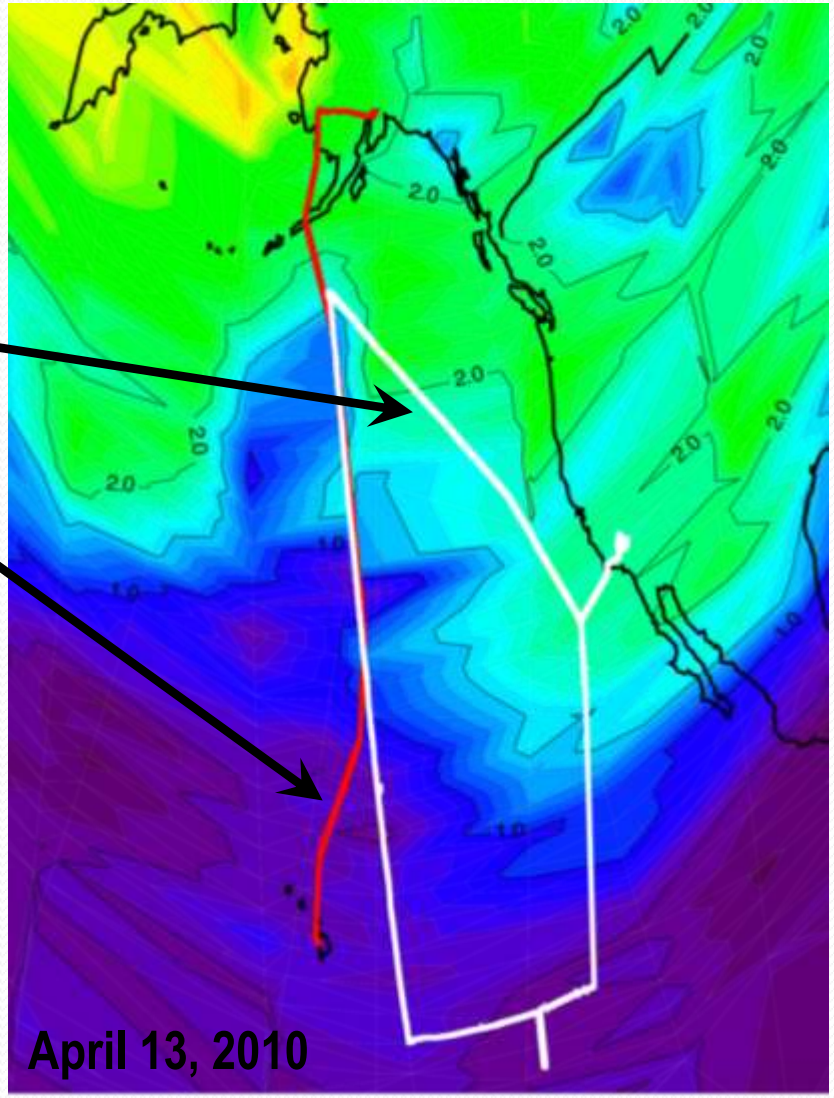
UAS Mission Flexibility and Profiling Capability

GloPac demonstration of aircraft profiling and satellite underflight

GloPac GH track in white

HIPPO NCAR GV in red

Aura satellite track follows the western side of GloPac flight



Ozone data from Microwave Limb Sounder (MLS), figure courtesy of Dr. Karen Rosenlof (NOAA)

Winter Storms and Pacific Atmospheric Rivers (WISPAR) Experiment

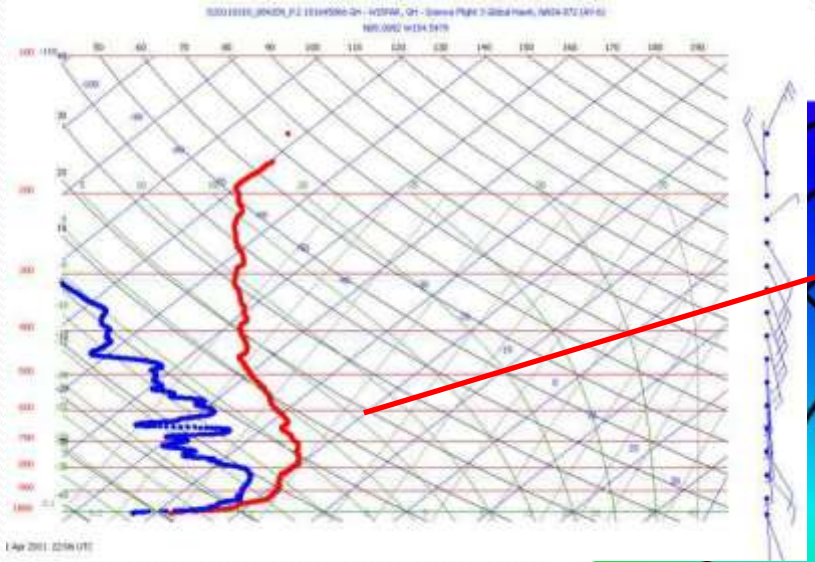
Mission Scientists: Gary Wick (NOAA/ESRL) and Michael Black (NOAA/AOML)

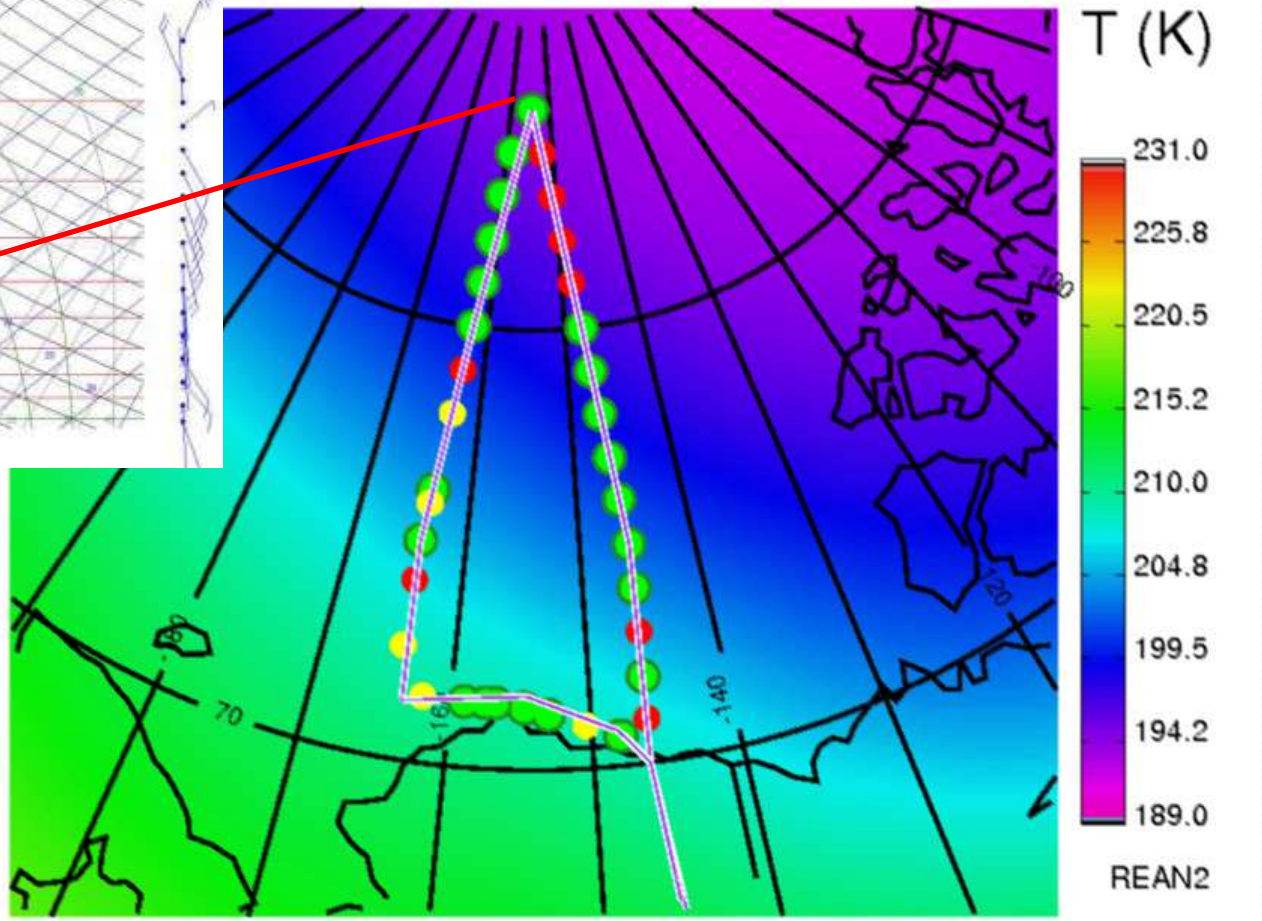
Partners: Yucheng Song (NOAA/NCEP), Janet Intrieri (NOAA/ESRL), Ryan Spackman (CU), NASA, NSF/NCAR

Dropsonde System – NCAR development / NOAA and NSF sponsorship
88 sonde total capacity

First dropsonde release from a Global Hawk

WISPAR Arctic Dropsonde Mission
9-10 March 2011

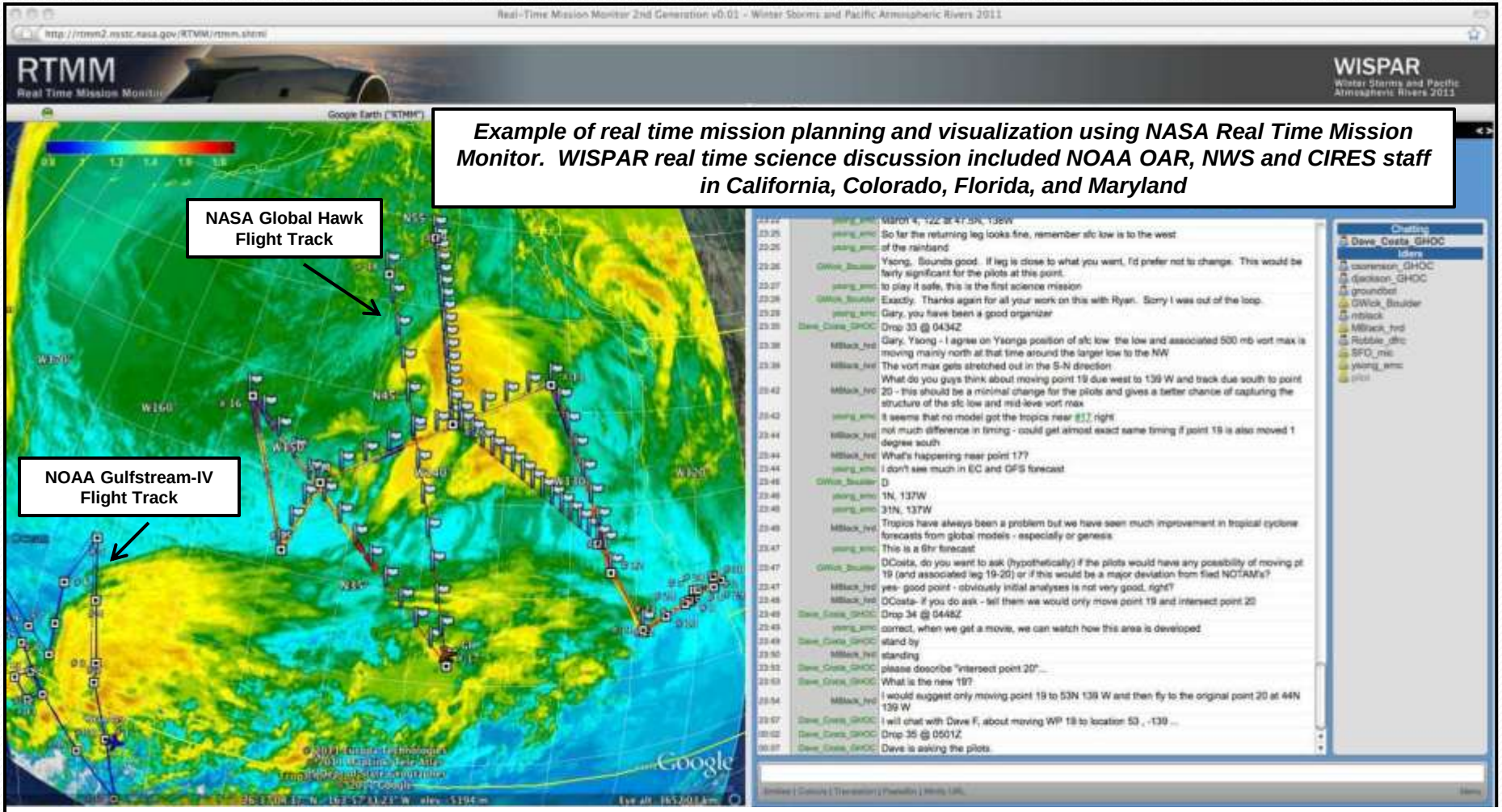




Drop locations superimposed on 70 mb temperatures from the NCAR/NCEP V2 reanalysis data

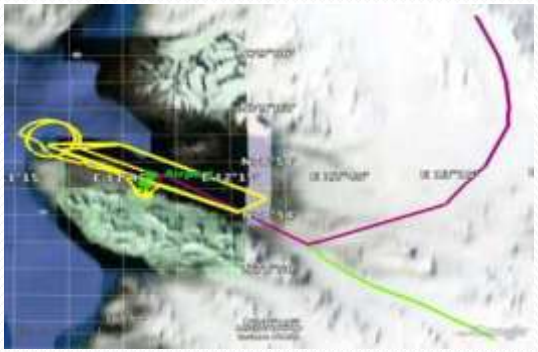
Courtesy of Leslie Lait, Paul Newman (NASA GSFC)

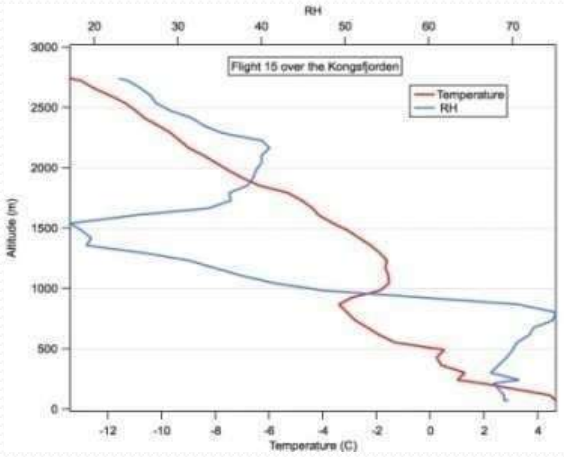
WISPAR Winter Storm Mission
3-4 March 2011

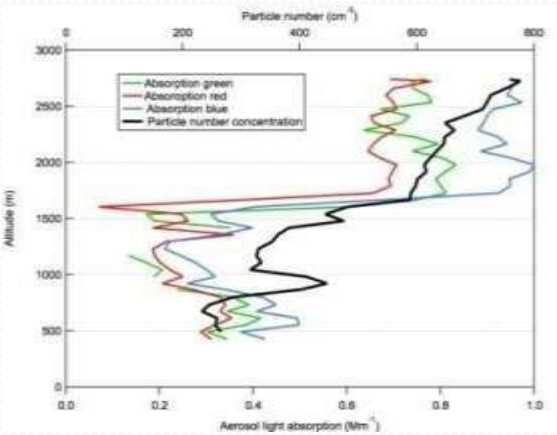


Winter storm mission flown on the eastern side by the NOAA Gulfstream-IV and on the western side by NASA Global Hawk. The Global Hawk historically released 70 dropsondes in a single flight covering 8000 nmi. The Global Hawk also remotely sensed atmospheric temperature and water vapor profiles continuously during the 24 hour mission using the NASA JPL High-Altitude Monolithic Microwave Integrated Circuit Sounding Radiometer (HAMSR).

Soot Transport, Absorption, and Deposition Study (STADS)







NOAA component of the Coordinated Investigation of Climate-Cryosphere Interactions (CICCI) collaboration with Norwegian and Russian scientists

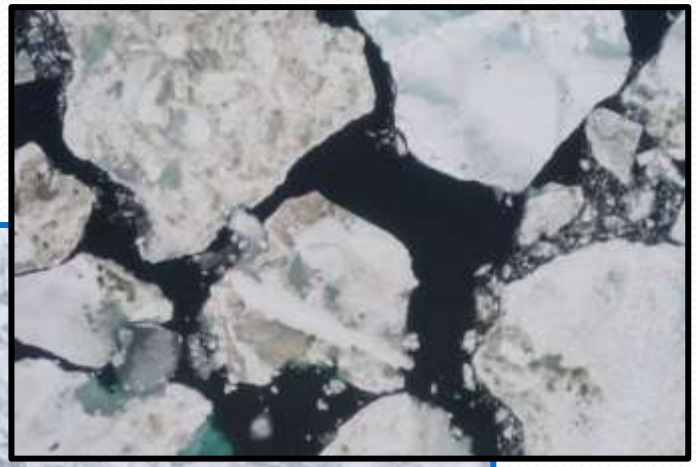
STADS Mission Scientists: Tim Bates and Patricia Quinn (NOAA/ESRL)

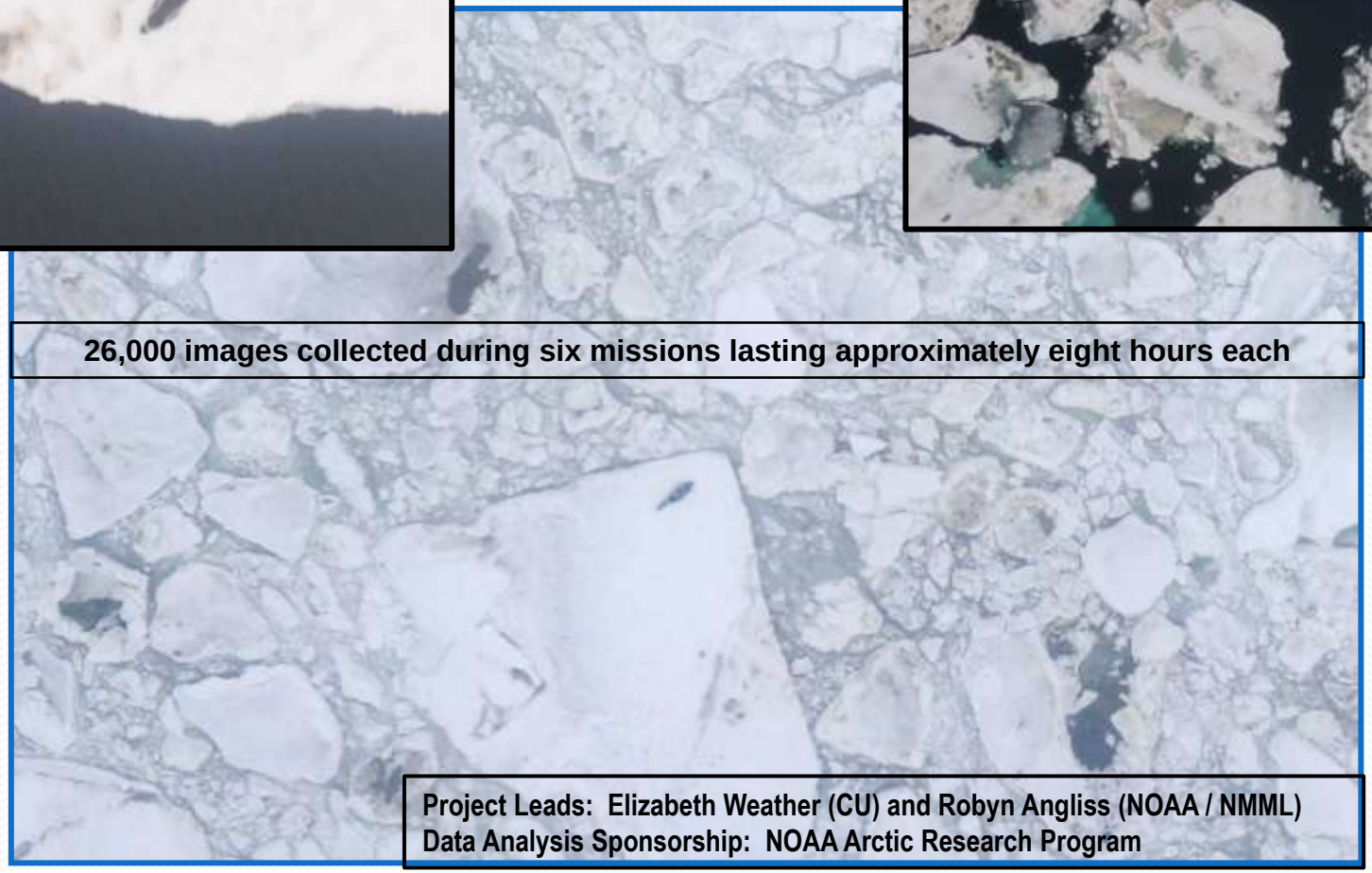
Next Steps

- Optimizing UAS observing strategies for:
  - Sea ice information
  - Wildlife assessments
  - Air quality and atmospheric chemistry process studies
  - Oceanic meteorological information
  - Real-time data delivery
  - Fast, effective image processing

- Identifying promising UAS technologies for:
  - Methane impact studies
  - Gravity and elevation information
  - Coastal mapping
  - Inland flooding and meteorological information

Evaluating Data Analysis Technology





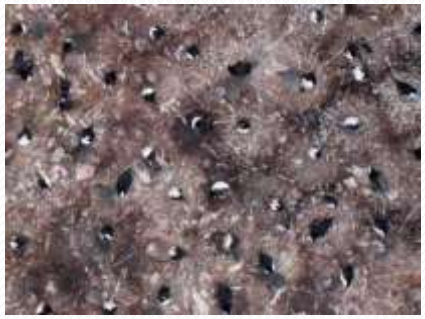
26,000 images collected during six missions lasting approximately eight hours each

Project Leads: Elizabeth Weather (CU) and Robyn Angliss (NOAA / NMML)
Data Analysis Sponsorship: NOAA Arctic Research Program

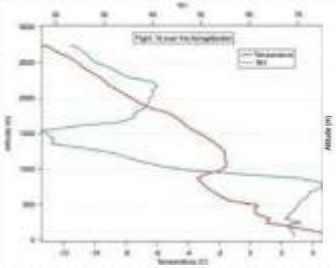
Directly Addressing Major Goals of NOAA Arctic Vision and Strategy

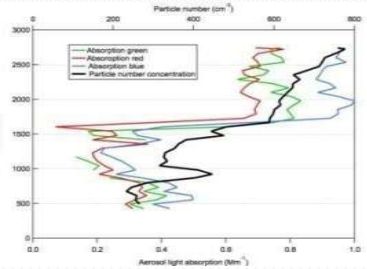
- Goal 1: Forecast Sea Ice
  - Real-time sea ice imaging
- Goal 2: Strengthen Foundational Science to Understand and Detect Arctic Climate and Ecosystem Changes
  - Marine mammal responses to sea ice loss
  - Climate observations including black carbon and stratospheric constituents
  - Base water-level information from expanded gravity data collection
  - Methane release concentrations and rates of change
- Goal 3: Improve Weather and Water Forecasts and Warnings
  - In situ vertical atmospheric profiling

Wide Range of Innovative UAS Observing Solutions

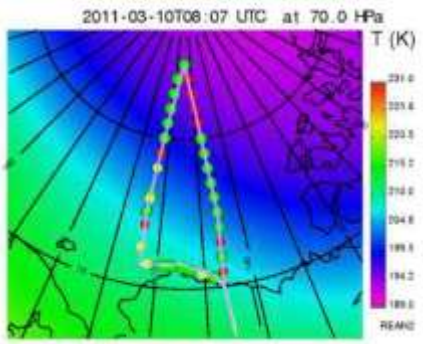


Quiet and Easily Transportable for High Resolution Imaging





Versatile Platform and Payload Capabilities for Low Altitude Profiling



High Altitude Long Endurance for Comprehensive Imaging and Profiling

Contact Information

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